

... וַיְהִי כָל-יְמֵי מְתוּשָׁלַח הַשָּׁעַר וְשָׁשִׁים שָׁנָה וְחֹשֶׁעַ מֵאָה שָׁנָה ...

All the days of Methusalem were nine hundred sixty and nine years ... (Genesis, 5: 27)

... voce magna clamavit: Lazare, veni foras!"

... He cried in a loud voice, come out, Lazarus, to my side! (St. John, 11: 43)

Cythereis mesa: Methusalem or Lazarus?

By

AVRAHAM HONIGSTEIN, FRANCIS HIRSCH, AMNON ROSENFELD & AKIVA FLEXER^{*)}

With 1 Plate

ABSTRACT

Two subspecies of the ostracode *Cythereis mesa* HONIGSTEIN, which were reported from the Late Santonian - Campanian strata in Israel, reoccur in Early Paleocene sediments after disappearance lasting the whole Maastrichtian stage.

Evolutionary strategies, explaining this phenomen, like heterochrony, iteration (Lazarus-effect), migration and exceptional survival (Methusalem-effect), are discussed. The possibility of redeposition can be excluded.

ZUSAMMENFASSUNG

Zwei Unterarten der Ostrakodenspezies *Cythereis mesa* HONIGSTEIN, die in den Ablagerungen des oberen Santons bis Campans in Israel gefunden werden, fehlen im Maastricht, treten aber erneut im unteren Paläozän auf. In dieser Arbeit werden verschiedene Richtungen einer möglichen Evolution,

wie Heterochronie, Wiederholung (Lazarus-Effekt), Migration und außerordentlich lange Lebensdauer (Methusalem-Effekt), diskutiert. Die Wiederablagerung in jüngeren Sedimenten kann ausgeschlossen werden.

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^{*)} Dr. AVRAHAM HONIGSTEIN, Ministry of Energy and Infrastructure, Oil and Gas section, 234 Yafo St., Jerusalem 94387; Dr. FRANCIS HIRSCH, Dr. AMNON ROSENFELD, Geological Survey of Israel, 30 Malkhei Yisrael St., Jerusalem 95501; Dr. AKIVA FLEXER, Department of Geophysics and Planetary Sciences, Tel Aviv University, Tel Aviv 69978.

1. GEOLOGICAL AND PALEONTOLOGICAL BACKGROUND

Soft Senonian - Paleocene sediments are widespread over Israel. The Late Coniacian - Campanian succession consists mainly of homogenous chalks, overlain by massive brecciated cherts of Late Campanian age. Argillaceous chalks dominate Maastrichtian strata. Paleocene sediments consist mainly of marls and marly chalks (FLEXER 1968). Most of these strata contain rather rich macrofossil and microfossil assemblages.

The Coniacian - Campanian chalks correspond to shallow-water environments in an inner to mid-shelf region. The paleodepth curve for these deposits shows a gradual sea-level rise (FLEXER et al. 1986), followed by a significant lowering of the sea-level during the Late Campanian. A renewed sea-level rise occurred during the Maastrichtian. The strata were deposited in a series of basins in an outer-shelf to upper-slope environment, with dysaerobic conditions on the bottom of the sea. The environment of the Paleocene sediments is similar to that of the Maastrichtian, though somewhat shallower and with more normal marine conditions.

The Senonian ostracode faunas of Israel were first described by HONIGSTEIN (1984). Ostracodes are relatively common in Late Coniacian - Campanian sediments and allow a biozonation into five ostracode assemblage zones (S-1 to S-5). During Maastrichtian times, only few ostracodes occur

(Biozone M). These biozones and their stratigraphic positions were correlated with zones and markers of other fossil groups (REISS et al. 1985; HONIGSTEIN et al. 1987).

The Senonian ostracode assemblages consist of more than 60 different species. Species of the subfamily Trachyleberidinae (e.g. group *Cythereis*) and of the genera *Brachycythere* and *Protobuntonia* are dominant as well as smooth forms (e.g. *Cythereella*). All ostracode species are marine types and point to sedimentation in a moderate shelf environment.

After the prominent defaunation of ostracodes (in number of species as well as in population density) during the Maastrichtian in Israel, Paleocene strata contain again richer assemblages of about 20 different species. The marine Paleocene faunas are dominated by the genera *Ordoniia*, *Mauritsina* and smooth forms (e.g. *Kritbe* and *Cythereella*). *Cristaeleberis reticulata* BASSIOUNI, 1971 and *Megommatocythere denticulata* (ESKER, 1968) (described by HONIGSTEIN 1984 as *Oertliella?* cf. *rasbaalbekensis*) are reported from Senonian strata and proceed into the Paleocene of Israel, as in neighbouring countries (e.g. BASSIOUNI 1971; BASSIOUNI and LUGER 1990). Two Late Santonian - Campanian subspecies of *Cythereis mesa* reoccur in Early Paleocene sediments after their disappearance lasting the whole Maastrichtian.

2. *CYHEREIS MESA*: OCCURRENCES AND EVOLUTIONARY STRATEGIES

2.1 THE OCCURRENCE OF *CYHEREIS MESA*

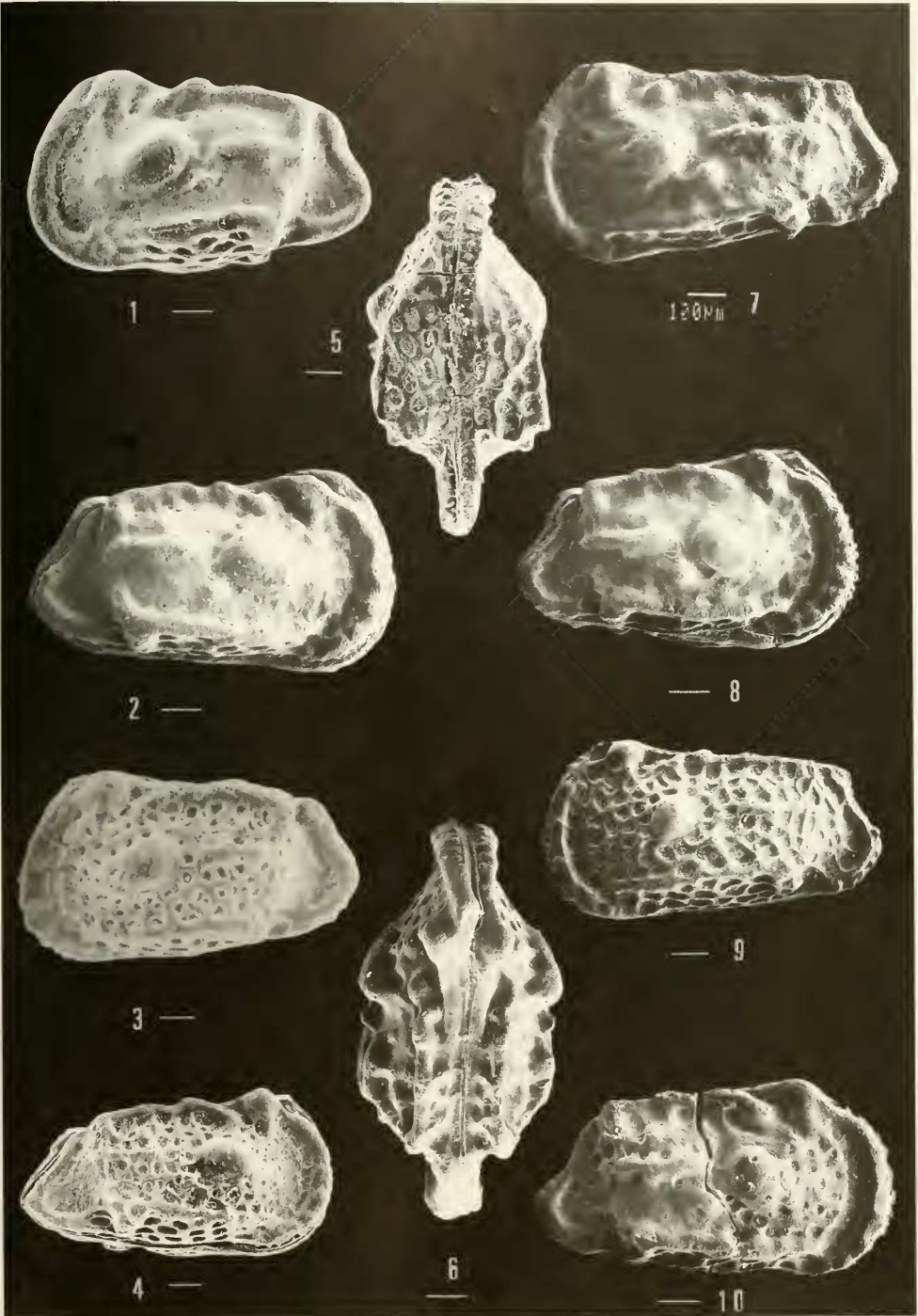
Cythereis mesa and its four subspecies were described from Senonian sediments by HONIGSTEIN (1984, see also HONIGSTEIN 1985). These forms are known hitherto only from Israel. *C. mesa* is a relatively large form, (0.8-1 mm length), which is characterized by a strong subcentral node, a distinct median ridge and a prominent posteroventral node. Its ventral view (Pl. 1, Fig. 5) is subtriangular and plain, because of the sharp edge of the elevated ventral ridge towards the contact margin. *C. mesa* probably does not belong definitely to the genus

Cythereis or to any other known genus of the Trachyleberidinae. However, because of its typical external features of the Cytheracea, as well as its partly preserved internal elements, it is attributed here to *Cythereis*.

The subspecies of *C. mesa* differ by their ornamentation of the carapace and the position of the posterior end. *C. mesa centroleviata* with a smooth carapace and *C. mesa ventroreticulata* with a reticulated carapace, both with a centrally pointed posterior end, occur in Late Coniacian - Late Santonian strata (Ostracode zones S-1 to S-3). The two subspecies with a

Plate 1

- Fig. 1 *Cythereis mesa mesa* HONIGSTEIN. - Female carapace, left valve, Har Tuv-1, No. T-7364, Campanian.
 Fig. 2 *Cythereis mesa mesa* HONIGSTEIN. - Male carapace, right valve, Shefaram-1, No. T-7361, Early Campanian.
 Fig. 3 *Cythereis mesa ventroreticulata* HONIGSTEIN. - Female (?) carapace, left valve, Shefaram-1, No. T-7074, Late Santonian.
 Fig. 4 *Cythereis mesa ventroreticulata* HONIGSTEIN. - Male carapace, right valve, Beer Sheva SH9, T-7177, Early Campanian.
 Fig. 5 *Cythereis mesa ventroreticulata* HONIGSTEIN. - Male carapace, ventral view, Har Tuv-1, No. T-7364, Campanian.
 Fig. 6 *Cythereis mesa mesa* HONIGSTEIN. - Female carapace, dorsal view, Nahal Havarim, SB 320, Early Paleocene.
 Fig. 7 *Cythereis mesa mesa* HONIGSTEIN. - Male carapace, left valve, Hor HaHar, HH 24, Early Paleocene.
 Fig. 8 *Cythereis mesa mesa* HONIGSTEIN. - Female carapace, right valve, Hor HaHar, HH 22, Early Paleocene.
 Fig. 9 *Cythereis mesa ventroreticulata* HONIGSTEIN. - Male carapace, left valve, Nahal Havarim, SB 304, Early Paleocene.
 Fig. 10 *Cythereis mesa ventroreticulata* HONIGSTEIN. - Female right valve, Sde Boqer, AR 559, Early Paleocene.



ventrally pointed posterior end, *C. mesa mesa* (smooth form; Pl. 1, Figs. 1-2) and *C. mesa ventroreticulata* (reticulated form; Pl. 1, Figs. 3-5), were described hitherto from Late Santonian - Campanian sediments (Zones S-3 to S-5; HONIGSTEIN et al. 1987). In Maastrichtian strata these ostracodes were not observed, even though they are relatively large and very distinctive.

In the type section of Paleocene strata in southern Israel and in two other nearby sections, sampled for the investigation of Early Cenozoic ostracodes, *C. mesa mesa* (Pl. 1, Figs. 6-8) and *C. mesa ventroreticulata* (Pl. 1, Figs. 9-10) reoccur in the lower part of the profiles, appearing several meters above the K/T boundary level and common in layers of the NP-3-NP-4 nannoplankton biozones (MOSHKOVITZ, GSI; pers. comm.). The Paleocene specimens of both subspecies of *C. mesa* are shown to be taxonomically identical with their Senonian counterparts (Pl. 1).

The possibility of redeposition of Late Cretaceous fossils in Paleocene sediments was taken into account, but can be excluded due to the good preservation of the ostracodes and the absence of coexisting Late Cretaceous foraminifera and calcareous nannoplankton in these samples (SIMAN-TOV and MOSHKOVITZ, GSI, pers. comm.). Therefore, the reappearance of the two subspecies of *C. mesa* after a 10 million years gap must be related to other factors.

2.2 DISCUSSION ON EVOLUTIVE STRATEGIES

The genetic mechanism, intended to warrant the survival of the original model throughout generations is only valid as long as viable living conditions remain relatively the same. Some species have a high adaptive tolerance, and thus a better possibility for long survival than very specialized taxa. The latter are more vulnerable to changing conditions, and their reaction is „perish or change“.

Heterochrony

The concept of paedomorphosis was developed by GOULD (1977), using HAECKEL's old concept for evolutive strategies, among which progenesis and neoteny, mimic backward evolution. The retardation or on the other hand, the acceleration of reproductive maturation can be caused by environmental changes. The strategy of progenesis, the speeding up of sexual maturity, is used when conditions improve dramatically and the organism feel the urge to take advantage of such optimal conditions, to reproduce themselves as fast as possible. On the contrary, once all niches are fully packed and among other factors, nutrients became scarce, the response of the organisms is neoteny, the slowing down and saving of the ontogenic process by retardation. These strategies can be observed in Triassic conodonts, preceding extinction, where the population changes match eustatic sea-level fluctuations (HIRSCH 1992).

Iteration

The fading away of a taxon does not automatically mean its extinction. Often, when conditions, similar to those before the disappearance of the species reoccur, restoration of that taxon takes place. This phenomenon, called by JABLONSKI Lazarus-effect, may be related with heterochrony.

Migration

Migration of fossil species in space and time occurs often. Nerineids, common in Europe during the Bathonian, were driven away by the boreal spread during the Callovian to the gondwanian shores of the Tethys. There, they found an ecologic shelter, evolved further and recolonized the northern epicontinental seas of the Tethys during the middle Oxfordian (HIRSCH 1979). Ostracodes, e.g. *Simeonella brotzenorum* SOHN, which is reported from the Ladinian of the Sephardic province, migrated during the Carnian into the Alpine realm (GERRY et al. 1990).

Exceptional survival

Extremely slow evolution rates can be observed in nearly every fossil group from the brachiopod *Lingula* to the common cockroach. This long-range phenomenon braves evolution like biblical old Methusalem. This may apply also to *Cristaeleberis reticulata* and *Megommatocythere denticulata*, which occur in Israel continuously from the Early Senonian till the Paleocene, crossing even the K/T boundary, which represents a barrier for many fossil groups.

2.3 THE CASE OF CYTHEREIS MESA

The two Late Santonian - Campanian subspecies of *C. mesa* reappear in similar quantities in Early Paleocene strata of Israel, after a gap of 10 million years. No redeposited fossils were found in these samples. Therefore, what evolutionary effect can be invoked for the re-occurrence of identical forms after such a long time span?

The disappearance of *C. mesa* during the Maastrichtian may be due to oxygen deficiency near the sea bottom. After the re-establishment of better ecological conditions during the Paleocene, a repetition of the species seems possible. But, generally Cytheracean species evolved fast and both subspecies surprisingly reoccur in our material (Lazarus-effect). But, where was the shelter for the species to migrate into during the Maastrichtian? *C. mesa* represents a relatively large and ornamented ostracode species that can be hardly overlooked. Although, it was hitherto reported only from Israel and not from adjacent areas with similar Maastrichtian and Paleocene rock formations, as Jordan and Egypt (e.g. BASSIOUNI 1971, BASSIOUNI and LUGER 1990), it can not be excluded that in the future, *C. mesa* will be found in Middle Eastern Maastrichtian sediments and appear to be another example of the Methusalem-effect. For the time being, the question remains unsolved.

REFERENCES

- BASSIOUNI, M. A. A. (1971): Ostracoda (Mauritsininae und Trachyleberidinae) und ihre Bedeutung für die Biostratigraphie des Maastricht und des Alttertiär von Jordanien. - Beih. geol. Jb., 106: 5-52; Hannover.
- BASSIOUNI, M. A. & LUGER, P. (1990): Maastrichtian to Early Eocene Ostracoda from southern Egypt. Paleontology, Paleoecology, Paleobiography and Biostratigraphy. - Berliner geowiss. Abh. (A), 120 (2): 755-928; Berlin.
- ESKER, G. L. (1968): Danian ostracodes from Tunisia. - Micropaleontology, 14 (3): 319-333; New York.
- FLEXER, A. (1968): Stratigraphy and facies development of Mount Scopus Group (Senonian - Paleocene) in Israel and adjacent countries. - Isr. J. Earth Sci., 17: 85-114; Jerusalem.
- FLEXER, A., ROSENFELD, A., LIPSON-BENITAH, S. & HONIGSTEIN, A., 1986. Relative sea level changes during the Cretaceous in Israel. - AAPG Bull., 70 (11): 1685-1699; Tulsa.
- GERRY, E., HONIGSTEIN, A., ROSENFELD, A., HIRSCH, F. & ESHET, Y. (1990): The Carnian salinity crisis: ostracods and palynomorphs as indicators of paleoenvironments. - In: WHATLEY, R. & MAYBURY, C. (eds.), Ostracoda and global events, 87-100; London (CHAPMAN & HALL).
- GOULD, S. J. (1977): Ontogeny and Phylogeny. - 501 pp.; Cambridge, Mass. (Belknap Press of Harvard Univ. Press).
- HIRSCH, F. (1979): Jurassic bivalves and gastropodes from northern Sinai and southern Israel. - Isr. J. Earth Sci., 28: 128-163; Jerusalem.
- HIRSCH, F. (1992): Patterns of evolution before extinction of Triassic conodonts. - Paleont. Soc., Spec. Publ., 6: 129; Knoxville, Te.
- HONIGSTEIN, A. (1984): Senonian ostracodes from Israel. - Geol. Surv. Israel, Bull., 78: 1-48; Jerusalem.
- HONIGSTEIN, A. (1985): *Cythereis mesa mesa* (Ostracoda), a correct name for *Cythereis mesa ventrolevuata* HONIGSTEIN, 1984. - Isr. J. Earth Sci., 34 (4): 240; Jerusalem.
- HONIGSTEIN, A., ALMOGI-LABIN, A. & ROSENFELD, A. (1987): Combined ostracod and planktic foraminifera biozonation of the Late Coniacian - Early Maastrichtian in Israel. - J. Micropaleont., 6 (2): 41-60; London.
- REISS, Z., ALMOGI-LABIN, A., HONIGSTEIN, A., LEWY, Z., LIPSON-BENITAH, S., MOSHKOVITZ, S. & ZAKS, Y. (1985): Late Cretaceous multiple stratigraphic framework of Israel. - Isr. J. Earth Sci., 34 (4): 147-166; Jerusalem.